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R.F. Burton, D.J. Clark, and C.M. Lyneis

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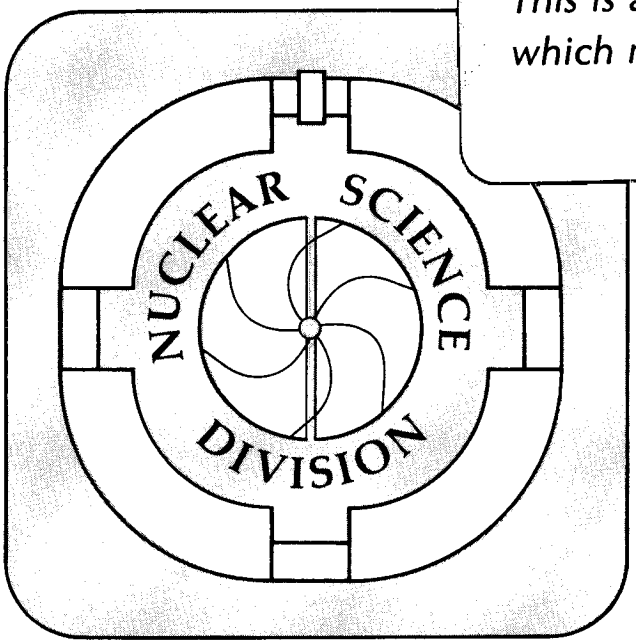

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DISCLAIMER

BEAM ATTENUATOR FOR THE LBL 88-INCH CYCLOTRON*

R. F. Burton, D. J. Clark and C. M. Lyneis

University of California
Lawrence Berkeley Laboratory, 1 Cyclotron Road, Berkeley, CA 94720, U.S.A.

A beam attenuator has been installed on the ECR injection line for the LBL 88-Inch Cyclotron, which gives fast attenuation of the beam by factors ranging from 2 to $4x10^9$.

The operation of the 88-Inch Cyclotron requires rapid changes in intensity of the beam on target by factors ranging up to 10^9. This range of adjustment is needed to obtain the proper intensity of beam on beam-monitoring phosphors, and to reduce the intensity for in-beam experiments such as detector tests and radiation damage studies of solid state components. The traditional methods for attenuation were closing of slits, turning off diffusion pumps, detuning the ion source or more recently detuning the injection line. These methods were either time consuming, incapable of giving enough attenuation or difficult to reverse.

The SuperHILAC group [1] developed an attenuation system for their injection line using a series of metal meshes inserted into the beam. Its advantages included use on the low energy injection line where the beam power was low, absence of radiation induced on the meshes and no change in beam emittance. This system was the basis of the one described here.

After the installation of the ECR source [2] and new injection line [3] on the 88-Inch Cyclotron it was possible to install an attenuator system in the injection line, where the beam energy is only 10 Q kV, where Q is the ion charge state. A position just before the charge analyzing magnet was chosen, so that the attenuator could be used with either cyclotron injection or atomic physics experiments. The system provides a choice of 6 meshes in line, each having a different transmission (Fig.1). Any combination of the meshes can be inserted in the beam line with air cylinder drives controlled by push button NIM modules in the control room and at the ECR source. Stainless steel bellows provide the vacuum isolation between the air cylinders and the beam line, preserving the 10^{-7} Torr vacuum. Insertion or removal takes about 1 second.

The meshes are Electromesh material, made by Buckbee Mears Co. They are made of nickel-plated copper, etched to form a mesh pattern (Fig. 2). We are using 3 different mesh

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patterns: 25, 40 and 100 holes/inch. These have attenuation factors of about 2, 3 and 6 respectively. We spot weld the meshes to frames, with one or several meshes on each frame. We are presently using combinations of meshes to give attenuation factors ranging from 2 on the first frame to 800 on the last frame. The present combination of meshes mounted on the 6 frames gives a choice of overall attenuation factors from 2 to 4×10^9. The buncher, which provides a beam increase of a factor of 3 or 4, is normally used to give finer attenuation control between steps of the attenuator. When using two or more meshes on one frame, the net attenuation depends on the relative alignment, so we use an optical transmission measurement on the bench to set the alignment before spot welding. The mesh thickness is .008 -.013 cm, enough to stop 5 MeV protons or 14 MeV/nucleon xenon.

In operation the beam attenuator has been very successful. Its location on the low energy part of the accelerator system limits the beam power to a few watts. Its advantages over other forms of attenuation are that it gives rapid, easily reversible attenuation over a wide intensity range. Also the beam optics is unchanged, because a uniform sample is taken across the beam. A downstream shield has been installed to eliminate the filling of the fine mesh holes by material sputtered from a nearby collimator. It has been observed that beam transmitted through the cyclotron may be attenuated more than beam at the source by a factor of 2 or 3. This can arise from a slight detuning of the beam line due to the steering effect of collimators whose potential depends on beam intensity, or from space charge effects. In this case the desired intensity can be reached by using the buncher.

Acknowledgements

This work was supported by the Aerospace Corporation.

References

[1] A. Ghiorso developed system. Final engineering by D. Vanacek and G. Behrsing.

[2] C. M. Lyneis, 11th Int'l Conf. on Cyclotrons and their Applications, Tokyo (1986) p. 707, (Ionics Publ. Co., Tokyo, 1987).

[3] D. J. Clark and C. M. Lyneis, 11th Int'l Conf. on Cyclotrons and their Applications, Tokyo (1986) p. 499, (Ionics Publ. Co., Tokyo, 1987).

Figure captions:

Fig. 1. Attenuator assembly on the bench with one attenuator inserted. The light colored region in the center of the inserted attenuator is where beam sputtered away the nickel coating.

Fig. 2. One mesh mounted in frame, with centimeter scale.

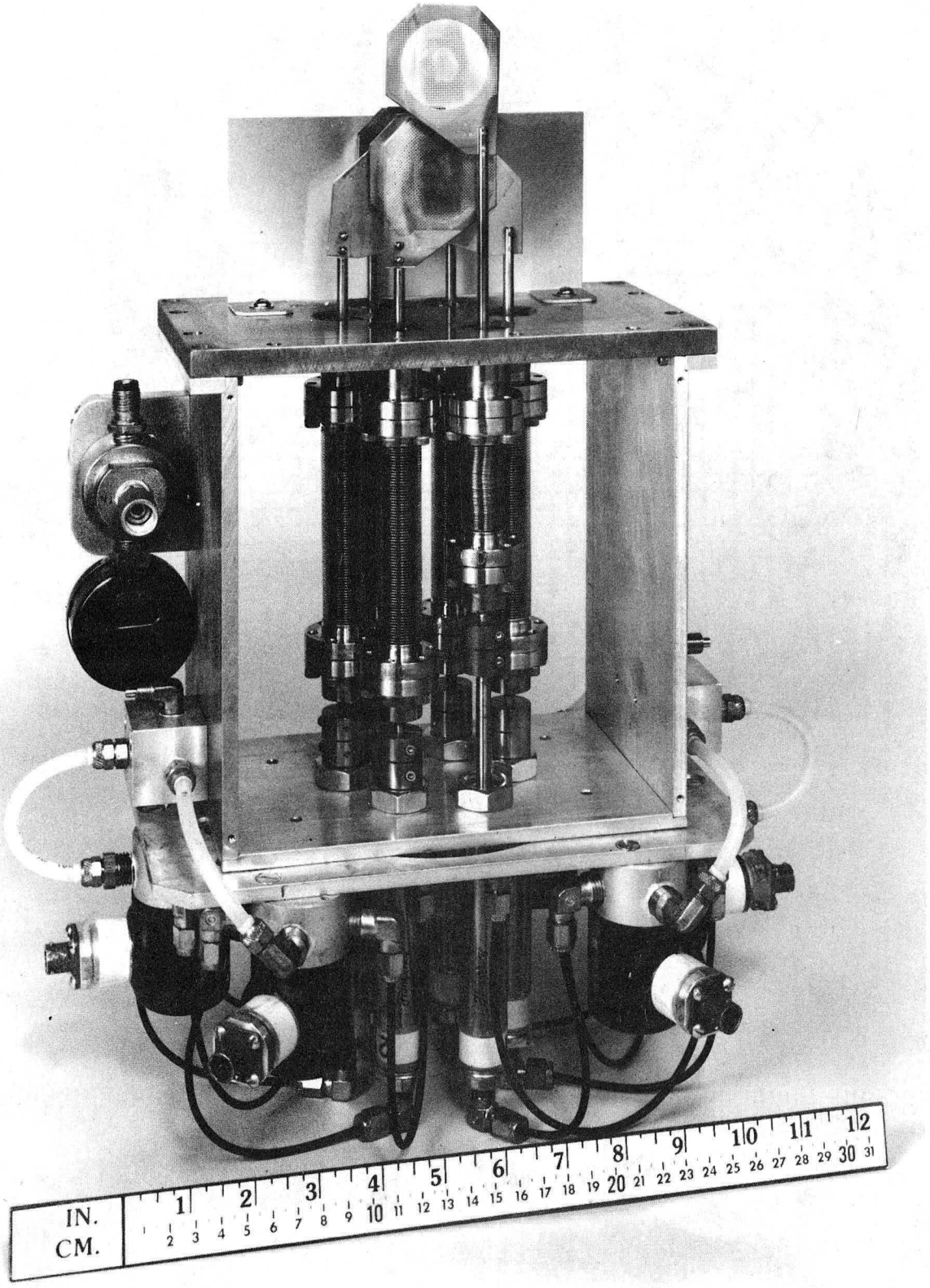

Fig. 1

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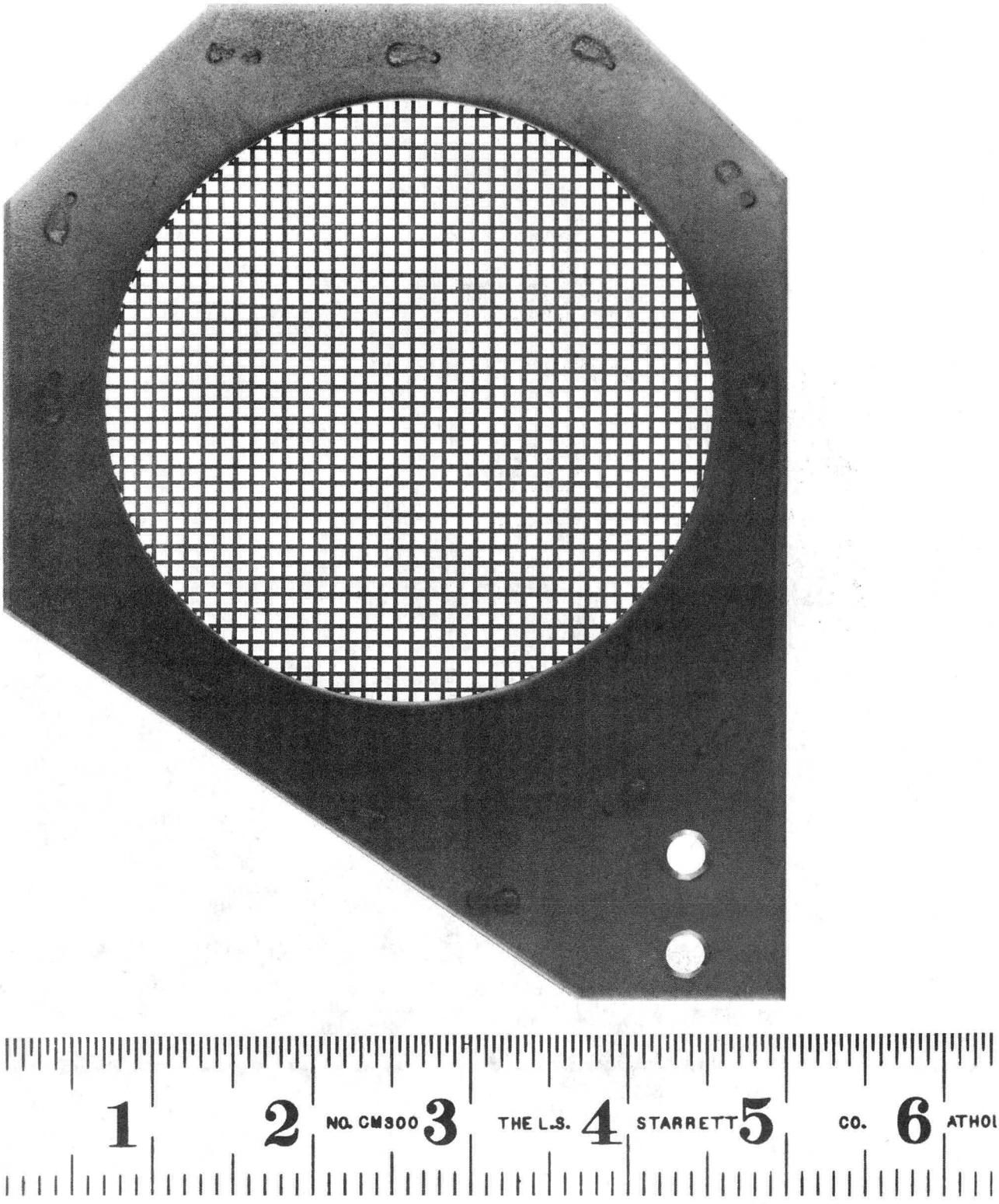

Fig. 2 - XBB 882-751

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TECHNICAL INFORMATION DEPARTMENT
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720